PROCEEDINGS OF THE BIOLOGICAL SOCIETY OF WASHINGTON
112(2):338–351. 1999.

On the entocytherid ostracods of the Brazos River basin and adjacent coastal region of Texas

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Abstract.—New records of entocytherid ostracods infesting crayfishes are recorded from the Brazos River basin in southeastern Texas, which extend the ranges of *Ankylocythere ancyla*, *A. sinuosa*, *Entocythere harrisi*, *E. reddelli*, and *Uncinocythere simondsi*. A review of the variations in the copulatory complex of *A. ancyla* is provided and the synonymy of *A. tiphophila* with *A. sinuosa* is proposed.

Upon the completion of his study of the crayfishes of the Brazos River basin and nearby areas, Douglas W. Albaugh (1973, 1975; Albaugh & Black 1973) sent sediments from the containers in which his specimens were preserved to the Smithsonian Institution. This report is based on the ostracods contained in these samples which were made available to us through the kindness of the late Horton H. Hobbs, Jr.

Five species of entocytherid ostracods were retrieved from 118 samples collected between 21 February and 8 March 1973. Hosts, which were identified by Dr. Albaugh (the subgeneric assignments were provided by Horton H. Hobbs, Jr.), include the following: *Cambarellus* (*Dirigicambarus*) *shufeldtii* (Faxon), *C.* (*Pandicambarus*) *ninae* Hobbs, *C.* (*P.*) *puer* Hobbs, *Fallicambarus* (*Creaserinus*) *fodiens* (Cottle), *Procambarus* (*Capillicambarus*) *brazoriensis* Albaugh, *P.* (*C.*) *hinei* (Ortmann), *P.* (*C.*) *incilis* Penn, *P.* (*Girardiella*) *simulans* (Faxon), *P.* (*Ortmannicus*) *a. acutus* (Girard), *P.* (*O.*) *texanus* Hobbs and *P.* (*Scapulicambarus*) *clarkii* (Girard). Insofar as we have been able to determine, all of the collections were made from open water; no crayfishes were taken from burrows. The ostracods, locality data, host and entocytherid identifications are deposited at the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Ankylocythere ancyla Crawford
Figs. 1a–h, 2a–h, 4

Ankylocythere ancyla Crawford, 1965:148, 149, 152, 153, figs. 1–3, 6, 7 [Type locality: "... in the city limits of Greensboro, Guilford County, North Carolina." Types: holotype, allotype, morphotype, and dissected male paratype USNM; paratypes in the collection of E. A. Crawford, Jr., and USNM. Host: *Cambarus latimanus* (LeConte) (=*Cambarus* (*Depressicambarus*) *catagius* Hobbs & Perkins, 1967)].

Ankylocythere species g Hobbs III, 1969: 32–34, figs. 4d–g, l.

Ankylocythere species h Hobbs III, 1969: 34–36, figs. 4h–k, l.

Except for the omission of the references to Hobbs III (1969), Andolshek & Hobbs (1986:10) included a compilation of all references in the literature to this ostracod.

Diagnosis of Texas material.—Shell length of male 336 to 378 (avg. 357) μm; shell height 196 to 224 (avg. 218) μm. Peniferum truncate to tapering with acute antero- and posteroventral angles. Clasping apparatus L-shaped with vertical ramus lon-

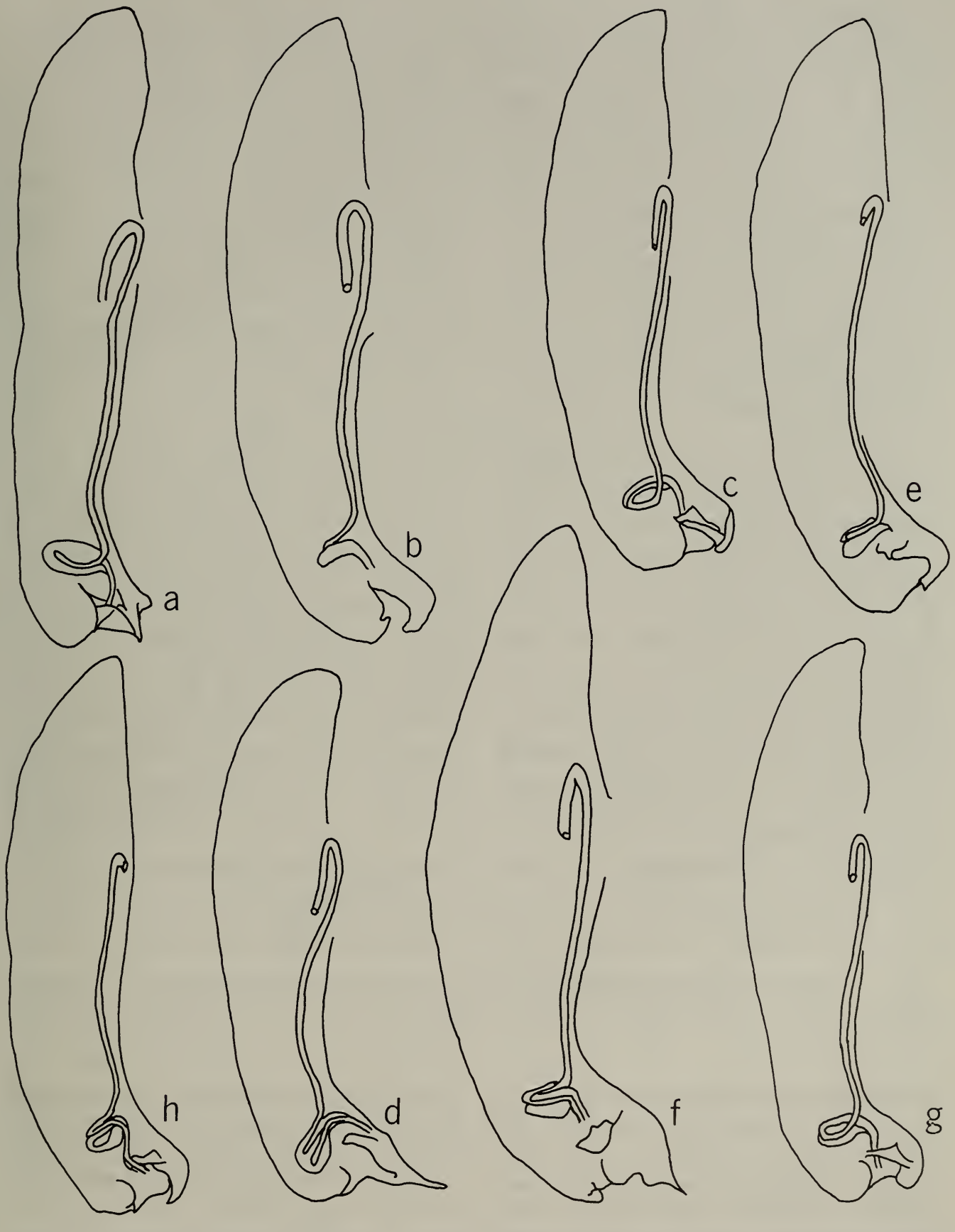

Fig. 1. Variation in penifera, lateral view, of *Ankylocythere ancyla* in Brazos River basin (a, h—Refugio Co.; b, f—Washington Co.; c, g—Fort Bend Co.; d—Austin Co.; e—Brazoria Co.); scale 0.02 mm.

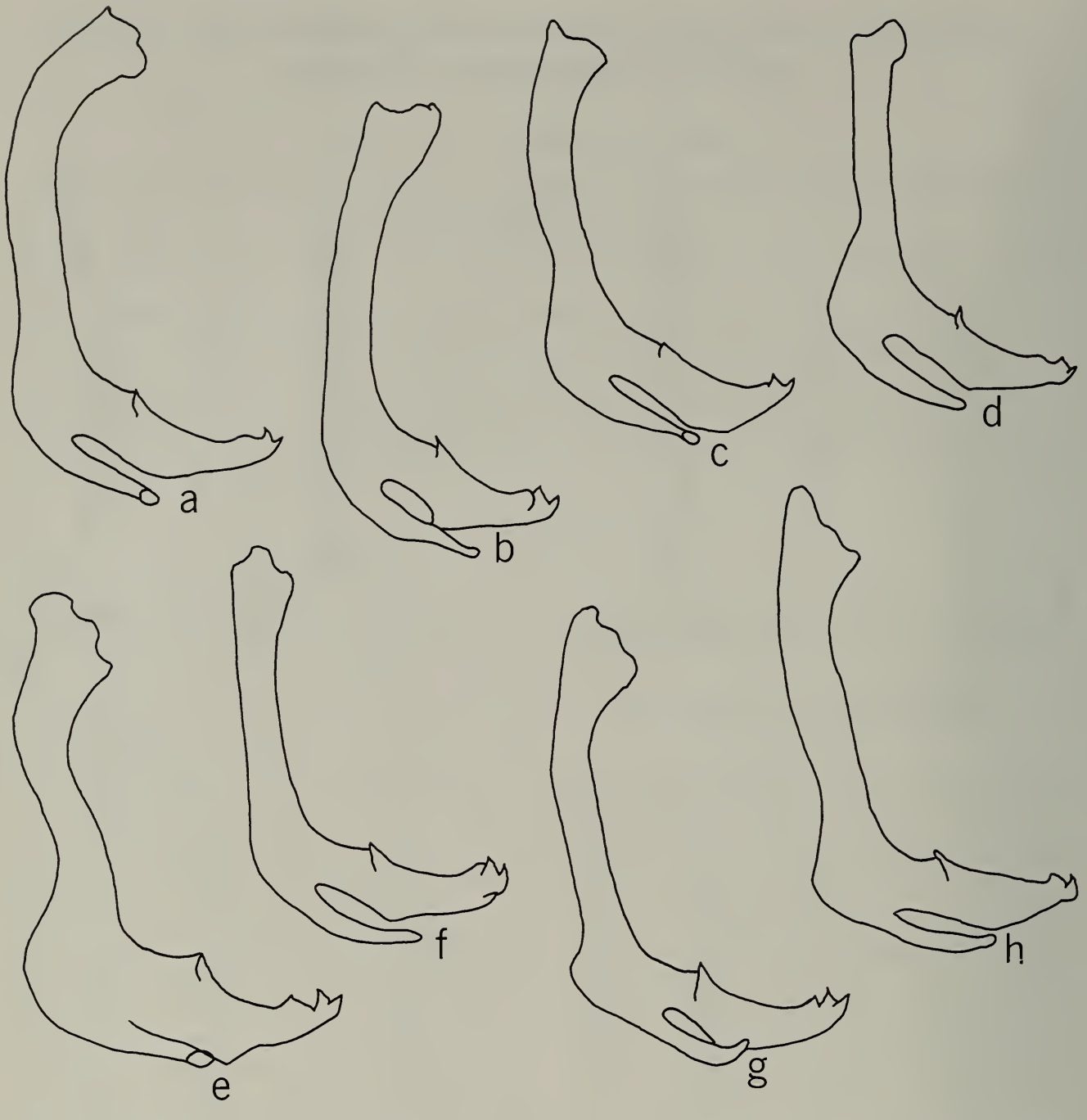

Fig. 2. Variation in clasping apparatus, lateral view, of *Ankylocythere ancyla* in Brazos River basin (a, h—Refugio Co.; b, e, g—Washington Co.; d—Fort Bend Co.; f—Austin Co.; c—Brazoria Co.); same scale as Fig. 1.

ger than horizontal ramus; latter with tooth on preaxial border near midlength, and postaxial border with long, curved talon reaching to midway between preaxial tooth and apex of ramus; extreme apical part of talon sometimes strongly curved mesially. Apex of clasping apparatus with 2 denticles.

Range.—Andolshek & Hobbs (1986) quoted the range of the species as cited by Hobbs & Peters (1977) as extending "... along the Atlantic and Gulf slopes from the Mobile River drainage in Alabama and Mississippi northeastward to the Potomac drainage in Virginia and in the New River Basin of North Carolina." The locality records established herein extend the westward limits some 750 kilometers to the Brazos basin in Texas.

Southeastern Texas records (Fig. 4).—Nineteen localities from the following counties: Austin (2), Brazoria (2), Brazos

(2), Calhoun (3), Fort Bend (2), Matagorda (1), Refugio (6), and Washington (1).

Remarks.—In his study of the entocytherids infesting burrowing crayfishes in the coastal plain between extreme eastern Texas and the Apalachicola Basin in Alabama and Florida, Hobbs III (1969) recognized 12 species belonging to the genus *Ankylocythere*. Specimens of two of these, *A.* species "g" and "h" were lent to us by Dr. Hobbs, and, after comparing them with representatives of *A. ancyla* from throughout its range, we are convinced that they are referable to this species. Thus there are few gaps in its known range. Andolshek & Hobbs (1986:14) reviewed available data on the size of the shell of this ostracod and found that the smallest individuals occurred in southeastern Georgia and the largest in Virginia. Those in North Carolina were, on the average, intermediate in size. The range in size of the material from along the coasts of Florida, Alabama, Mississippi, Louisiana, and Texas reported herein falls within that cited for the species in southeastern Georgia (length, 315 to 399 μm; height 175 to 245 μm). Thus it appears that the shells of southern populations of *A. ancyla* are smaller than those occurring in the more northern parts of the range.

A cursory examination of the ventral part of the peniferum would suggest that a dimorphic condition exists in this appendage, one in which the anteroventral extremity is produced in a subspiculiform prominence (Fig. 1d), and in the other, subtruncate (Fig. 1e). That the difference is more in the angle from which the penifera are viewed rather than due to morphological variation becomes apparent when those of a number of specimens are compared. In this ostracod, the basic structure of the ventral extremity of the peniferum is more clearly observed in specimens from the eastern part of the range where a broad concavity exists between the acute cephloventral and rounded posteroventral extremities (See fig. 4a in Andolshek & Hobbs (1986)). In specimens from the Brazos region, the anteroventral angulate extension often appears to be more strongly produced, and its base to bear a thickened, sclerotized prominence, which when viewed at some angles, seems to project posteriorly or posteroventrally; also the anteroventral apex of the posteroventral prominence is procurved, diminishing the maximum diameter of the concavity, and is frequently rather strongly sclerotized. (For variations compare Fig. 1b, c, e, g, h). Thus, whereas the ventral extremity of the penifera of the eastern and western members of the species appear to be markedly different, the contrast is less marked than seems apparent when only a superficial comparison is made.

Among other variations noted in the copulatory complex of this ostracod are the thickness of the junction of the horizontal and vertical rami of the clasping apparatus and the curvature of the vertical ramus. In specimens from Washington County, TX, males were found that possess a sinuous vertical ramus (Fig. 2e), and in the area of the junction of the rami there occurs a conspicuous thickening (Fig. 2e). Even though different, this variance must be considered to be within the range of variation in the species. For example, in one specimen one of the pair of clasping apparati exhibits such a thickening and the other resembles the more frequently observed apparatus (Fig. 2f, g). Considerable variation occurs in the curvature of the vertical ramus and in that of the talon (Fig. 2a–h).

Hosts.—In the Brazos Basin, *A. ancyla* is known to infest *F.* (*C.*) *fodiens*, *C.* (*P.*) *ninae*, and *P.* (*S.*) *clarkii*, and has been retrieved from collections containing all of the crayfishes known to occur in the area except *C.* (*P.*) *texanus*, *P.* (*C.*) *hinei*, and *P.* (*C.*) *brazoriensis*; rarely, however, was it found in collections containing representatives of *C.* (*P.*) *puer*, *C.* (*D.*) *shufeldtii*, and *P.* (*C.*) *incilis*.

Entocytherid associates.—In the 19 localities in which this ostracod was found, it was the only one infesting the crayfishes in nine sites. Its most frequent associate (in 9

localities) was *A. sinuosa*, and only rarely was it found with *E. reddelli* (2), and *U. simondsi* (1).

Ankylocythere sinuosa (Rioja)
Figs. 3, 5

Entocythere cambaria.—Hobbs, 1941:4 [in part].

Entocythere (Cytherites) heterodonta sinuosa Rioja, 1942a:203, 204, figs. 5, 6 [Type locality: La Cueva Chica, San Luis Potosi, Mexico. Types: not extant. Host: *Procambarus acutus cuevachicae* Hobbs 1941.]; 1953:287.

Entocythere (Cytherites) sinuosa.—Rioja, 1942b:688, 689, 695, 696, fig. 20; 1943a: 564; 1943b:576.

Entocythere sinuosa.—Hoff, 1944:330, 332, 356.—Rioja, 1949:321, 322 [in part], figs. 13, 14; 1951:170; 1953:291, 292.—Tressler, 1954:138; 1959:731, fig. 28.190.—Hobbs, 1957:431.—Crawford, 1959:173, 178.

Ankylocythere sinuosa.—Hart, 1962:127; 1964:246.—Crawford, 1965:149.—Reddell, 1965:156; 1970:395; 1971:18; 1981: 82.—Hobbs, 1966:70, fig. 18; 1971:34–35, fig. 22.—Ferguson, 1968:501.—Hobbs & Walton, 1968:246.—Baker, 1969:293.—Reddell & Mitchell, 1969:6; 1971:142.—Young, 1971:399–409.—Hart & Hart, 1974:1, 2, 14, 21, 22, 29–31, 34, pl. 3: figs. 11–13, pl. 41.—Hobbs III, 1969:5, 14, 20–22, 27, 30, 32–35, 39, 41, 43, 46, 55, 65, 66, 71, 74, 78, 79, fig. 5a–k; 1975:281, 290; 1978:506; 1982: 2.—Hobbs & Peters, 1977:13; 1991:66, 67.—Hobbs & McClure, 1983:773.

Entocythere tiphophila Crawford, 1959: 150, 151, 173–178, 180, 181, figs. 31–37 [Type locality: roadside ditch 9.1 miles (14.6 km) SE of University of South Carolina stadium, Richland County, South Carolina, on St. Rte. 48. Types: USNM. Hosts: *Fallicambarus* (*C.*) *uhleri* and *Procambarus* (*F.*) *troglodytes*].—Hart, 1962:123, 128.

Ankylocythere tiphophila.—Hart, 1962:128; 1964:245.—Crawford, 1965:149.—Hobbs, 1966:71, fig. 16.—Ferguson, 1968:501.—Peters, 1974:74; 1975:iii, 5–8, 10, 13, 20, 22, 23, 27, 45, figs. 2c, 6k, 14.—Hart & Hart, 1974:15, 20, 33, pl. 4: figs. 6–8, pl. 45.—Hobbs & Peters, 1977: iii, 3–7, 9, 12, 16, 19–22, 28, 40, 41, 43, 46, 49–54, 70, fig. 5, map 5.—Hobbs, 1981:140, 499, 501.—Hobbs & McClure, 1983:773.

Ankylocythere tiphophyla.—Hobbs, Holt, & Walton, 1967:77 [erroneous spelling].

Diagnosis of Texas material.—Shell length of male 329–378 (avg. 350) μm; shell height 168–210 (avg. 191) μm. Peniferum varying from deeply cleft to truncate with tapering acute anteroventrally projecting prominence. Clasping apparatus L-shaped with vertical ramus longer that horizontal ramus; latter with truncate, almost straight, anteroventrally projecting talon situated slightly proximal to midway between preaxial tooth and apex of ramus; apex of apparatus with 2 denticles.

Range.—On the Gulf of Mexico versant, from the Cordillera volcanica Transversal along the Gulf and Atlantic (lower piedmont and coastal plain) slope to the York River Basin in Virginia. Hart and Hart (1974:33) also reported it from two localities in Ohio, records that should be confirmed.

Southeastern Texas records (Fig. 5).—This ostracod is the most widespread of the entocytherids within the study area, occurring in 94 of the 118 localities represented among the collections examined.

Hosts.—In southeastern Texas this ostracod was associated with three crayfishes: *P.* (*O.*) *a. acutus*, *P.* (*S.*) *clarkii* and *P.* (*G.*) *simulans*, but has been found in collections containing specimens of all of the other species in the area. In the collections from 94 localities where the ostracod was found, *P.* (*O.*) *a. acutus* was a potential host in 60 of them, *P.* (*S.*) *clarkii* in 52, *P.* (*G.*) *simulans* in 31, *P.* (*C.*) *incilis* in 17, and *F.* (*C.*) *fodiens* in 14. All of the other crayfish-

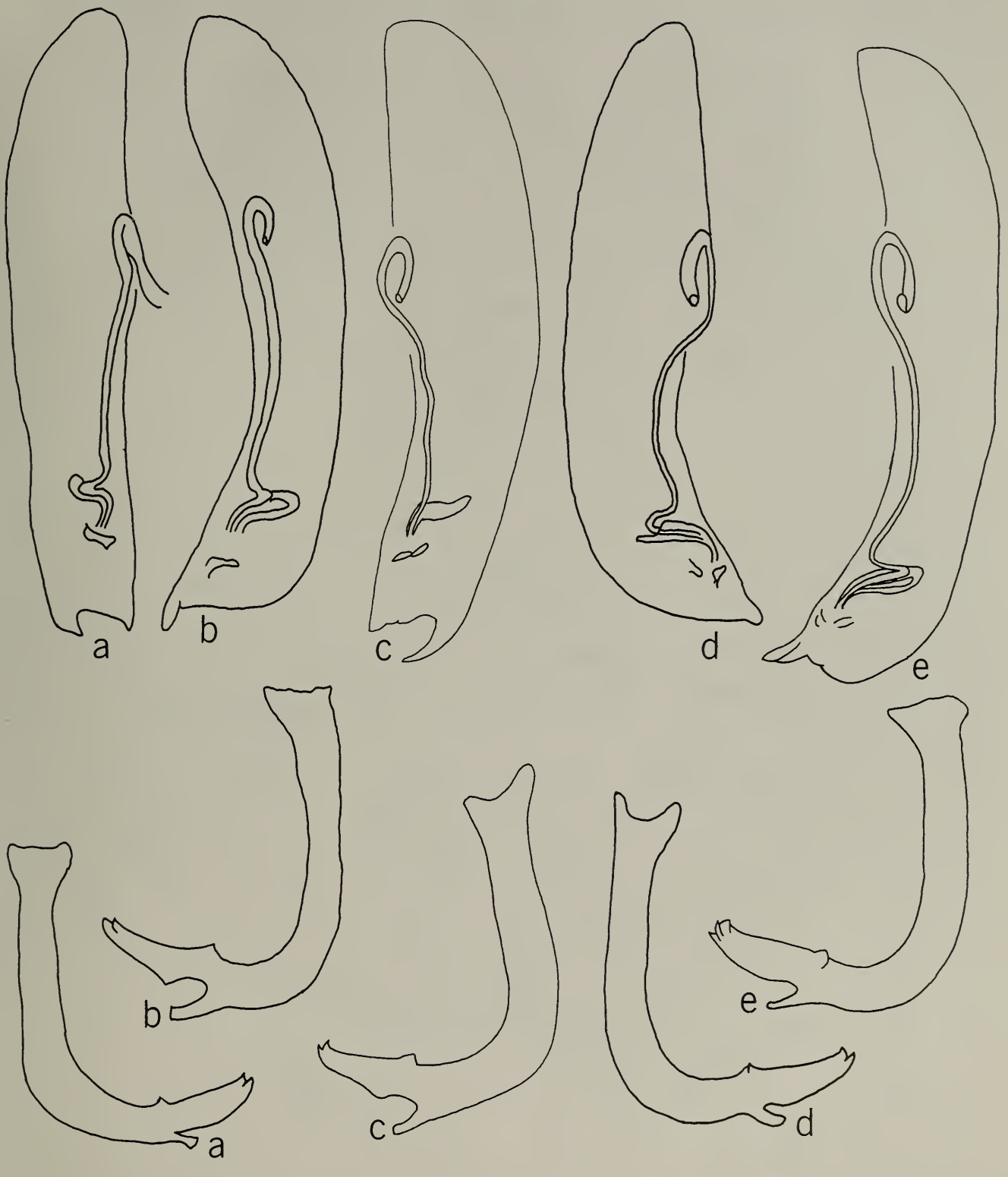

Fig. 3. Variation in male copulatory complex, lateral view, of *Ankylocythere sinuosa* (a—Tamaulipas, Acequia, Mexico; b—Burleson Co, TX; c—Robertson Co., Texas) and *Ankylocythere tiphophila* (d—Dorchester Co., South Carolina; e—Newport News, Virginia); same scale as Fig. 1.

es were present in fewer than 10 of the collections.

Entocytherid associates.—In the 94 localities where *A. sinuosa* was found, it was the only ostracod infesting the crayfish(es) in 57 of them. In 26 localities it shared the host(s) with *E. reddelli*, in eight with *A. ancyla*, and two each with *E. harrisi* and *U. simondsi*.

Remarks.—There is nothing remarkable concerning the size of the animals or in the structures employed in distinguishing this

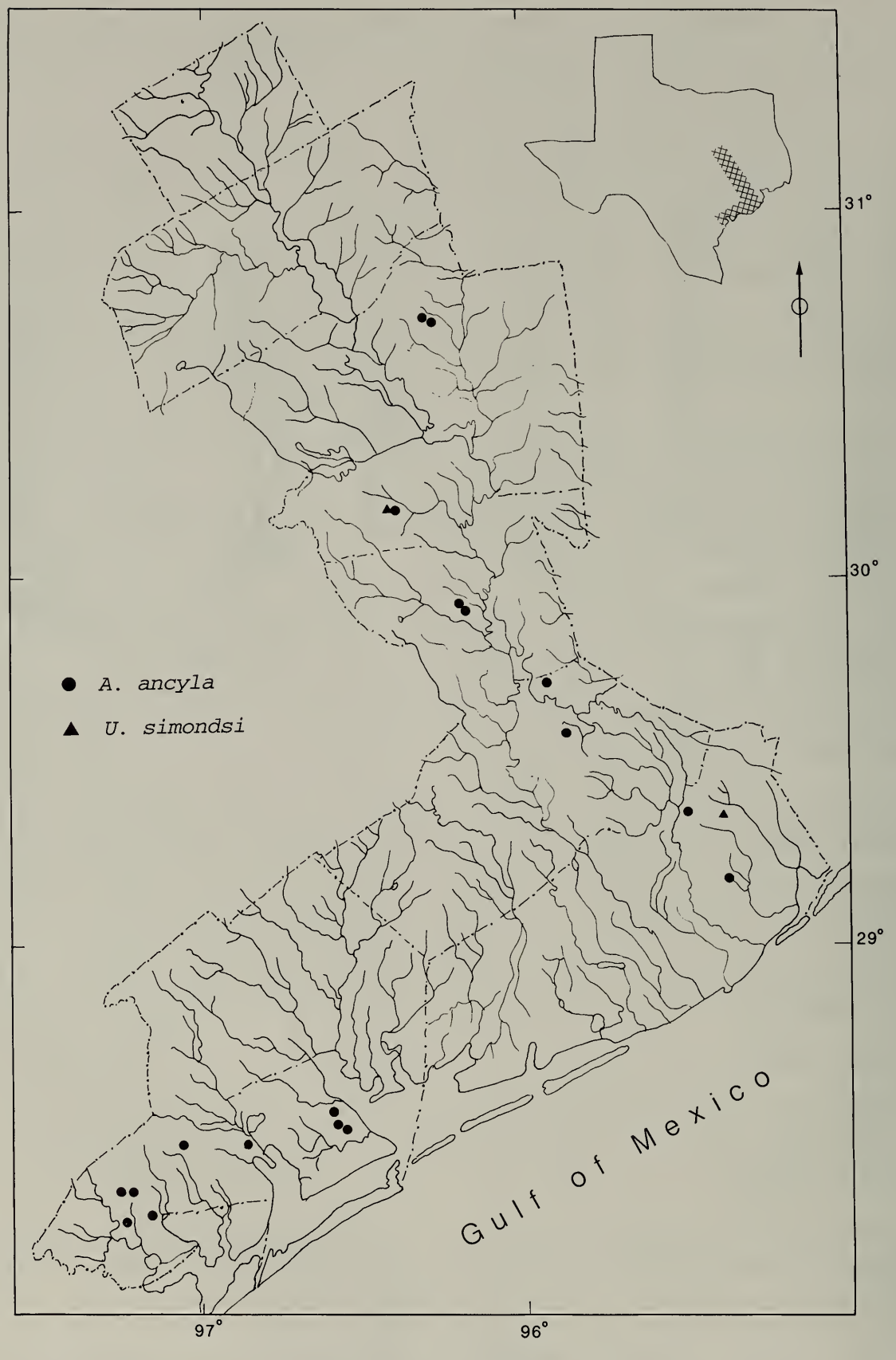

Fig. 4. Distribution of *Ankylocythere ancyla* and *Uncinocythere simondsi* in the Brazos River drainage.

ostracod from its congeners. The length of the shells of males ranges from 329 to 378 μm and the height from 168 to 210 μm. Hobbs (1971), in reporting on this ostracod in Mexico, cited similar ranges in size: 0.34 to 0.37 mm and 0.19 to 0.22 mm, respectively.

Perhaps because of the apparent discon-

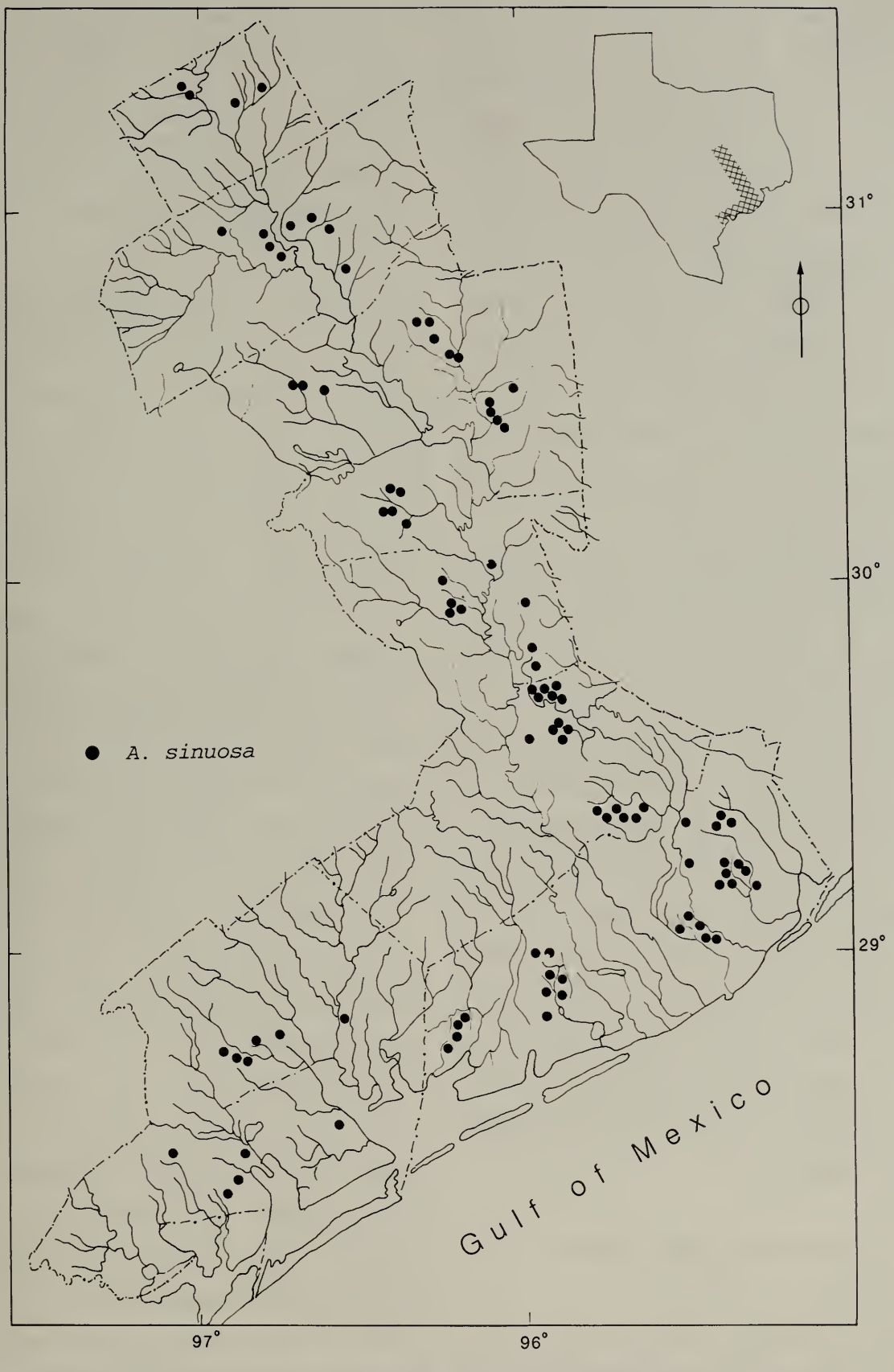

Fig. 5. Distribution of *Ankylocythere sinuosa* in the Brazos River drainage.

tinuity between the ranges of *A. sinuosa* and *A. tiphophila* and the seemingly consistent presence of a cleft peniferum in the range of the former and its absence in that of the latter, there seemed to be no reason to suspect that they represented two forms of a single species. With the acquisition of collections almost merging the ranges of

the two species, we were prompted to compare specimens from Mexico to Virginia (Fig. 3) and found that in the Gulf Coastal area forms with a cleft peniferum, the only feature that has served consistently to separate the two (Fig. 3a, c), occur in localities in which some of the males were lacking a cleft (Fig. 3b, d, e). Moreover, in specimens from Bleckley County, Georgia (see Andolshek & Hobbs, 1986:fig. 12a), the peniferum is distinctly excavate, tending toward the cleft condition. In view of the discovery of an almost continuous range and no character that can be relied upon invariably to separate the two, we propose that *A. tiphophila* be considered a synonym of Rioja's *Entocythere sinuosa.*

Reinforcing this proposal is the seemingly subparallel clinal distribution with respect to the size of the shell. Andolshek & Hobbs (1986:25) reviewed in tabular form the shell size reported for *A. tiphophila* revealing that the largest specimens occur in North Carolina (410 μm) and Virginia (390 μm), smaller ones in South Carolina (346 μm), and the smallest in southeastern Georgia (321 μm). Perhaps significant are the sizes reported by Hobbs III (1969:74) for *A. sinuosa* occurring from eastern Texas to the panhandle of Florida. The mean shell length is 323 μm as compared with one of 321 μm in the material from southeastern Georgia. The cline, however, seems to be reversed between eastern Texas and Mexico, for the mean shell length for specimens from Mexico was reported by Hobbs (1971: 36) to be 350 μm.

Entocythere harrisi Peters
Fig. 6

Entocythere harrisi Peters, 1975:32–33, figs. 5a, 6e, f, 7a [Type locality: Rocky Creek 4.3 mi (6.9 km) E of U.S. Hwy 29 on U.S. Hwy 60, Amherst County, Virginia. Types: holotype and allotype, USNM; paratypes, USNM, H.H. Hobbs III, and DJP. Hosts: *Cambarus* (*C.*) *bartonii bartonii* (Fabricius), *C.* (*Hiaticambarus*) *longulus* (Girard), and *C.* (*P.*) *acuminatus* Faxon].—Hobbs & Peters, 1977:iv, 5, 9, 12–14, 21, 29, 33, 36, 41, 45, 47, 51, 52, 54, 55, 60, 61, 64, fig. 25; 1982:314; 1989:328.—Andolshek & Hobbs, 1986:30. [The references cited here constitute a complete bibliography for the species.]

Diagnosis.—Shell length of male 441–570 (avg. 477) μm; shell height 210–300 (avg. 244) μm. Peniferum truncate distally. Clasping apparatus "with postaxial border [slightly] bowed into heellike prominence at junction of horizontal and vertical rami, junction thickened; mesial surface of area of junction without flange; horizontal ramus without oblique ridges on mesial surface" (Hobbs & Peters 1977:51).

Range.—The most recent summary of the range of this ostracod was that of Hobbs & Peters (1977:52) who based their records, except for the type locality, on female specimens. In the present study we have become convinced that the characters they used for distinguishing between the females of this species and those of their *E. internotalis* (=*E. elliptica* Hoff, 1944) are not reliable. This conclusion is based upon the observation that in two collections of *E. harrisi* (one from Pike County, Arkansas, and another from Angelina County, Texas) containing several male and females, none of the latter possess the type of genital apparatus similar to those that were identified with that species in North Carolina and Virginia. Instead, the genital apparatus of the Arkansas and Texas females are indistinguishable from those of *E. elliptica* and *E. reddelli.* Thus we believe this ostracod is represented in collections only by the holotype (from Amherst County, Virginia) and the specimens cited herein from the Brazos River basin, Texas.

Remarks.—With the new records cited herein for the males of this species, we are inclined to propose a clinal distribution in size with respect to shell height. As the largest member is reported from Virginia

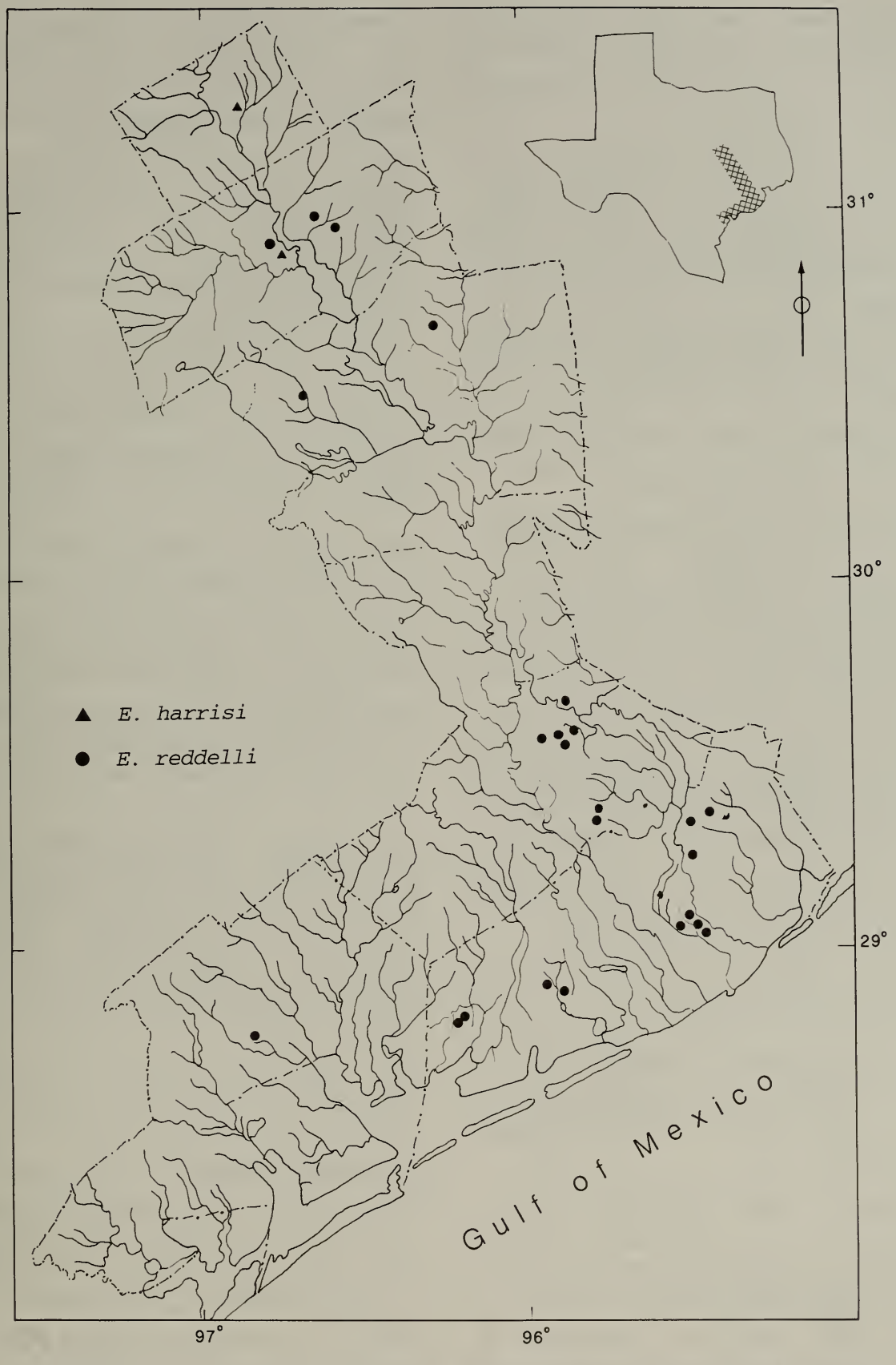

Fig. 6. Distribution of *Entocythere harrisi* and *Entocythere reddelli* in the Brazos River drainage.

(300 μm), smaller members occur from Pike Co., Arkansas (265 μm) and the Brazos River drainage (256 μm), with the smallest (224 μm) appearing in Angelina, Texas. However, when the shell length is compared, the largest member remains in Virginia (570 μm) and the smallest (456 μm) in Angelina, Texas, whereas members from

the Brazos River basin (490 μm) and Arkansas (476 μm) appear reversed. This may be due to the small number of specimens available for examination.

Southeastern Texas records (Fig. 6).—A male from each of the following localities: 4.0 mi (6.4 km) E of Marlin, Falls County, and McLaughlin Creek, 12.5 mi (20 km) E of Cameron on U.S. 90 at Branchville, Milan County.

Hosts.—In both localities this ostracod was found on *P.* (*G.*) *simulans* and *P.* (*O.*) *a. acutus.*

Entocytherid associates.—*A. sinuosa* was present in the two Brazos localities.

Entocythere reddelli Hobbs & Walton
Fig. 6

Entocythere reddelli Hobbs & Walton, 1968:243–246, fig. 2a–d [Type locality: Golden Fawn Cave, 8 mi (12.8 km) NNE of Boerne, Kendall County, Texas. Types: holotype, allotype, and paratypes, USNM; paratypes, Academy of Natural Sciences of Philadelphia and H.H. Hobbs III. Host: *P.* (*S.*) *clarkii* (Girard)].—Reddell & Mitchell, 1969:6.—Reddell, 1970: 395.—Hobbs, 1971:40.—Hart & Hart, 1974:83, 92–93, pl. XXVII: figs. 11–15, pl. LII.—Hobbs III, 1975:281.—Hobbs & Peters, 1977:iv, 5–7, 9–10, 12, 14, 29, 36, 41, 43, 45, 47, 52, 54, 55, 73; 1982: 313.—Andolshek & Hobbs, 1986:30. [These references constitute what we believe to be a complete bibliography for the species.]

Diagnosis.—Shell length of male 546–581 (avg. 564) μm; shell height 280–294 (avg. 287) μm. Peniferum subtruncate ventrally and possessing rounded antero- and posteroventral extremities. "Clasping apparatus with postaxial border at junction of horizontal and vertical rami produced in heellike prominence and junction thickened; mesial surface of area of junction with angular flange, apex of angle reaching level proximal to proximal tooth on preaxial margin of horizontal ramus, horizontal ramus lacking long oblique ridge extending across mesial surface. Female genital apparatus composed of ventrally directed subspiculiform projection arising from bipartite base, latter embedded in amorphous mass" (Hobbs & Peters 1977:55), second antenna with appendix at base of terminal claws conspicuously enlarged, pectinate, bearing 2 or 3 broad teeth or as many as 6 finely divided denticles.

Range.—In addition to its presence in Kendall County, Texas, Hart & Hart (1974: 93) reported its occurrence in Greene County, Arkansas, and Sumner County, Kansas. Hobbs & Peters (1977:55) also reported it from the Catawba, French Broad, and Hiwassee basins in North Carolina. Twenty-five localities in the Brazos River basin of southeastern Texas are cited here.

Southeastern Texas records (Fig. 6).—Twenty-five localities from the following counties: Brazoria (8), Brazos (1), Burleson (1), Fort Bend (7), Matagorda (4), Milan (1), Robertson (2), and Victoria (1).

Remarks.—Except for the distribution of this ostracod in the Brazos River basin, its range is poorly known. The total absence of records in what appears to be the central part of its range is disturbing, but there is little reason to suspect that the type locality lies on its western limit, and if and where its range and that of *E. cambaria* Marshall and *E. illinoisensis* Hoff meet or intersect to the north have not been determined.

Hosts.—In the Brazos basin, *E. reddelli* was found infesting *P.* (*O.*) *a. acutus* and *P.* (*S.*) *clarkii.* It also occurred in collections containing one or both of these crayfishes along with one or more of the following: *C.* (*D.*) *shufeldtii*, *C.* (*P.*) *ninae*, *C.* (*P.*) *puer*, *C.* (*P.*) *texanus*, *F.* (*C.*) *fodiens*, *P.* (*C.*) *brazoriensis*, *P.* (*C.*) *incilis*, and *P.* (*G.*) *simulans.*

Entocytherid associates.—In all 25 localities in which this ostracod was found, it was associated with *A. sinuosa*, and in one of them *A. ancyla* (hosts: *P.* (*O.*) *a. acutus* and *P.* (*S.*) *clarkii*) was also present; in an-

other of these localities *U. simondsi* was infesting the same two host species.

Uncinocythere simondsi Hobbs & Walton
Fig. 4

Entocythere simondsi Hobbs & Walton, 1960:17, 20–21, figs. 1–10 [Type locality: Dunn Creek, 1.9 mi (3 km) west of Fighting Town Creek on Hell's Hollow Road, Fannin County, Georgia. Hosts: *C.* (*C.*) *bartonii* and *C.* sp. (=*C.* (*D.*) *latimanus*)].

Uncinocythere simondsi.—Hart, 1962:138. [A complete bibliography for the species is presented by Andolshek & Hobbs, 1986:39.]

Diagnosis.—Shell length of male 329–343 (avg. 336) μm; shell height 154–196 (avg. 175) μm. Copulatory complex of peniferum terminating distally in bifid tip. Clasping apparatus L-shaped with preaxial border bearing 3 distinct teeth; postaxial border entire, lacking any excrescence; distal extremity with 3 denticles.

Range.—From Illinois, Kentucky, and North Carolina southward to Brazoria and Washington counties, Texas, and northern Florida, previously known no farther west than Mississippi (Hart & Hart 1974; Hobbs & Peters 1977, 1982; Andolshek & Hobbs 1986).

Southeastern Texas records (Fig. 4).—This ostracod was found in the following localities: 2 mi (3.2 km) N, 2 mi (3.2 km) E of Brenham on St Rte 90, Washington County; and 1.25 mi (2 km) E of Rosharon on Farm Rd 1462, Brazoria County.

Hosts.—*Procambarus* (*S.*) *clarkii* was one of the hosts in both of the Brazos collections in which this ostracod was found. In one of them, *P.* (*O.*) *a. acutus* was also present, and in the other, *P.* (*G.*) *simulans* was in the container from which the ostracods were removed.

Entocytherid associates.—In both of the localities in which this ostracod was found, *A. sinuosa* and *E. reddelli* also were present. In the collection from Washington County, *A. ancyla* also was found with them.

Acknowledgments

We extend our thanks to the late H. H. Hobbs, Jr. who encouraged us in this endeavor and provided the materials, guidance, and insight for this study. We are also grateful to Horton Hobbs III for his criticism of the manuscript and to Brian Kensley, Ray Manning, and Karen Reed for their assistance.

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